Malmstrom Air Force Base, 546th Missile Squadron **HAER NO.** MT-138
(Minuteman III Missle Facilities)
Great Falls vicinity
Cascade County
Montana

Written Historical and Descriptive Data
Field Notes

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office - Denver
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HISTORIC AMERICAN ENGINEERING RECORD

MALMSTROM AIR FORCE BASE, 546th MISSILE SQUADRON (MINUTEMAN III MISSILE FACILITIES)

HAER NO. MT-138

Location:	Malmstrom Air Force Base (MAFB) is located near the City of Great Falls, Cascade County, Montana. Its 564th Missile Squadron has five Minuteman III Missile Alert Facilities (Papa, Quebec, Romeo, Sierra and Tango) and 50 associated Launch Facilities. The Missile Alert Facilities (MAFs) are located in Pondera and Toole Counties, Montana, and their associated Launch Facilities (LFs) are in Pondera, Toole, and Chouteau Counties.
Present Owner:	MAFB, US Air Force (USAF)
Date of Construction	Constructed as a Minuteman II system in 1965-1966; converted to a Minuteman III system in 1975
Architect:	Ralph M. ParsonsCompany
Builder:	Morrison Knudsen Company and Associates
Present Use:	Deactivated Minuteman III Missile Alert Facilities (MAF) and Launch Facilities (LF)
Significance:	The 564th is an Intercontinental Ballistic Missile (ICBM) squadron based at Malmstrom Air Force Base, Montana. The fifty Minuteman ICBMs maintained and controlled by the 564th Missile Squadron (MS) were integral components of a massive Cold War defense system developed between the early 1960s and mid-1970s. The Minuteman system was designed to protect the United States from a possible nuclear attack as well as to provide a strategic deterrence, a cornerstone of American defense policy of the era. At the peak of the program, the nation's Minuteman arsenal had a total of some 1,000 operational missiles deployed at a series of northern Air Force Bases, including 200 at Malmstrom.

The first Minuteman I missiles of the early 1960s represented a significant advancement in ICBMs technology, standing fueled and ready for almost immediate launch upon appropriate higher command. The entire span of time from the launch of a Minuteman missile to arrival at target took half the time of the fueling process alone of its ICBM predecessors. The Minuteman I was followed by two major system upgrades or generations, the

Minuteman II introduced in the mid-1960s and Minuteman III of the early to mid-1970s. Unlike its elders, the Minuteman III carried three bombs instead of just one. With its three bombs rated at 200 kilotons each, a Minuteman III warhead was less powerful than a Minuteman II and its single 1.2 megaton bomb. Its three bombs, however, could be independently positioned to hit separate targets, dispersing destructive energy over a much broader geographic area.

An immense and distinctive defense infrastructure supported the nation's Minuteman arsenal. The missiles themselves were deployed in individual, below-ground silos known as Launch Facilities (LF). Operations at a group of ten LFs and missiles were remotely monitored and controlled by a single Missile Alert Facility (MAF), which included above-ground living quarters and a highly-secure, below-ground control and command center. A squadron operated five MAFs, and Air Force Bases with missile wings hosted either three or four squadrons.

The 564th was one of four missiles squadrons at Malmstrom, and the last to be established there. Constructed in 1965-66, the 564th MS facilities originally accommodated Minuteman II missiles. In addition to a larger more powerful warhead and enhanced operational and support systems, the second-generation Minuteman II system incorporated important changes in the architectural design of MAF and LF structures which were intended to improve survivability of equipment and personnel in the event of a nuclear attack. A decade later, in 1975 the 564th MS facilities were modified to accommodate the more technologically complex Minuteman III missile. While this third generation marked the last in the Minuteman series, operational and support systems saw continued technological updates in the ensuing years.

Lessening of Cold War tensions in the 1980s and beyond resulted in the gradual reduction of the United States' Minuteman arsenal. At Malmstrom, the 564th was selected for deactivation in 2006, and the process was completed the following year. Only 450 Minuteman missiles remain ready for launch in the nation today (2008).

PART I. HISTORICAL INFORMATION:

Malmstrom Air Force Base History

The establishment of MAFB came as a result of local and national concern over the outbreak of World War II. In 1941, the Great Falls Chamber of Commerce approached Montana senators Burton K. Wheeler and James E. Murray regarding the possibility of a military installation being built in the city.[1] In 1941, land was surveyed at a location approximately 6 miles east of Great Falls, as well as at 10 other sites across the northern US, to find a suitable site to support bomber training. Great Falls was ultimately chosen and on 8 June 1942 construction began on the Great Falls Army Air Base (GFAAB). Informally known as East Base, this name distinguished the units that would serve at GFAAB from the already existing 7th Ferrying Group, which was located at nearby Gore Field.

The primary mission of GFAAB was to serve as a training and logistics hub for the B-17 Bombardment Groups (BG). The GFAAB was assigned to the 2nd Air Force, and on 30 November 1942, the first B-17 Flying Fortress landed at the base. The GFAAB would house the headquarters of the 2nd BG and its four squadrons, the 2nd, 385th, 390th, and 401st Bombardment Squadrons (BS).[2] One squadron remained at GFAAB while the remaining three units served at Cut Bank AAB, Glasgow AAB, and Lewistown AAB in Montana. Training of the bombardment groups occurred until October 1943, when they left for the European Theatre of Operations, specifically North Africa and England.

A secondary mission was established in October 1943 when the 7th Ferrying Group moved from Gore Field to GFAAB after the completion of the B-17 BG training program.[3] This mission was to establish an air route between Great Falls and Ladd Field in Fairbanks, Alaska. This route was established as part of the Lend-Lease program to supply the Soviet Army with aircraft and supplies to fight Nazi Germany, given the US was not physically prepared at this time to go on an early offensive in World War II. Through the continuation of the Lend-Lease Program, several additional military planes utilized the air route, including the P-39, C-47, B-25, and A-20. Male pilots flew some aircraft in, while the Women Air Force Service Pilots (WASPs) flew in other airplanes. Other aircraft, such as the B-25 Mitchell Bomber, arrived by rail and were assembled on-site. These aircraft, flown by US and Soviet pilots, continued on the Alaskan-Siberian Route through Canada to Ladd Field in Fairbanks, Alaska. From there, they were turned over to the Soviet Union, where they were flown in defense of the Soviet Union against Germany.[4]

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[1] Jane Willits Stuwe, *Air Transport Command – Army Air Forces: East Base 1940-1946* (self published: 1974), 125.
[2] Curt Shannon,"Malmstrom Air Force Bases Traces Its Beginning Back to 1939," *The Great Falls River's Edge*, 4 no. 40 (2007), 18.
[3] Ibid.
[4] Ibid., 18-19.

Like many military facilities, after World War II GFAAB assumed a more administrative/supportive role. GFAAB primarily served in support of Alaskan military installations, although the 4th Air Force, a reserve training unit, was stationed at the base from October 1946 to March 1947. In 1947, the entire US military underwent a major reorganization, and the USAF was separated from the US Army. That same year, GFAAB officially became the Great Falls Air Force Base (GFAFB). Not only would the base see a new name, but within months, it would also begin to respond to the Cold War escalation.

On 12 June 1948, the Soviet Union began closing off automotive, rail, and water routes into Berlin from West Germany. This situation brought to the forefront issues with the lack of a negotiated pact with the Soviets regarding passage rights to Berlin. As a result, the possibility of another war occurring so shortly after the conclusion of World War II concerned Western military leaders. Rather than engage in direct confrontation over ground routes, Western military leaders opted to take to the air to help Berlin, which had only 35 days of food and 45 days of coal remaining. By 24 June 1948, the US had plans in place for *Operation Vittles* and two days later the first American cargo planes took off. Although the cargo planes were stationed at various bases in Germany, GFAFB served as the only replacement aircrew training site for C-54s activated as part of the 517th Air Transport Wing (ATW).[5]

In the aftermath of World War II and the ongoing Korean War, GFAFB became active in domestic defense as part of the North American Air Defense mission.[6] In early 1950, the 29th Air Division was activated at GFAFB. The 29th Air Division included fighter interceptor squadrons, an aircraft control and warning squadron, and ground observer attachments. By 1953 the 29th Air Fighter Interceptor Squadron was activated under the 29th Air Division.[7]

In 1954, the base was aligned under the Strategic Air Command (SAC) and the 407th Strategic Fighter Wing (SFW) was assigned to GFAFB. This wing included KB-29 air refuelers in support of F-84s both in case of attacks on the US or possible attacks against the Soviet Union.[8] A year later, on 1 October 1955, GFAFB was officially renamed Malmstrom Air Force Base in honor of Colonel Einar A. Malmstrom, who died on an administrative mission in a T-33 training aircraft.[9] In 1957, the 407th SFW was deactivated and replaced by the 4061st Air Refueling Wing (ARW). The 4061st was joined by the 407th Air Refueling Squadron (ARS) (comprised of KB-29s) and the 97th ARS (comprised of KC-97s). These squadrons remained active until 1961.[10]

[5] Ibid., 19.
[6] Stuwe, 126.
[7] Shannon, 19.
[8] Ibid.
[9] Stuwe, 125.
[10] Shannon, 19.

The arrival of such units began to define MAFB as a major domestic defense site, and by 1957 MAFB was responsible for the 24th North American Aerospace Defense Command (NORAD) region. The 24th NORAD region was comprised of four fighter/interceptor squadrons and radar sites across the western US and into Canada, and was identified as an alternate NORAD command post.[11] MAFB would host or be considered for, over the next several years, several radar and missile defense systems. These systems included AN/FPS-20 and AN/FPS-6 radars installed in 1957, the SAGE (semiautomatic ground environment) system direction center built in 1959, and testing for the Nike-Hercules and Bomarc-B intercept missile systems. Although they represented the latest technology at the time, the systems had weaknesses, including easy targeting by the Soviet radars. The USAF was determined that the Nike-Hercules and Bomarc-B missiles were better utilized in the defense of metro areas rather than military facilities. Therefore the final decision was not to house these at MAFB. When these programs were discontinued or reassigned to new locations, MAFB would become one of the six proposed missile sites for the newly-developed Minuteman Missile. The Minuteman missile's domestic defense role was solidified on 23 December 1959 when the Air Force Ballistic Missile Committee chose MAFB as host to the first Minuteman ICBM base.

On 15 July 1961 the 341st Strategic Missile Wing (SMW) was activated at MAFB. The base historic legacy of strategic defense, the copious amounts of space, and missile range to Soviet targets, made MAFB an ideal location for the newly-developed solid-fuel Minuteman missiles system. Ultimately, MAFB was chosen because of its northerly location, its established road network, suitable soils, and scarcity of people, which minimized potential casualties in the event of a nuclear confrontation with the Soviet Union.[12]

The Minuteman Missile at MAFB

The 341st SMW was the first Minuteman missile wing in the nation. It was originally activated as the 341st BG (Medium) on 15 September 1942 in Karachi, India. The group served in central Burma against enemy transportation units until 1944, when they relocated to China to perform sea sweeps and attacks on Japanese inland shipping. The 341st BG was inactivated on 2 November 1945 and returned to the US where it was redesignated as a reserve unit at Westover Field, Massachusetts from 27 December 1946 to 27 June 1949. In 1955, the 341st Bombardment Wing (BW), Medium was activated at Abilene AFB, Texas where the wing flew B-47 Bombers and KC-97 Stratotankers in strategic bombardment and air refueling training operations. The 341st BW was inactivated on 25 June 1961 and within just days was redesignated the 341st SMW at MAFB. Once at MAFB, it had three Strategic Missile Squadrons (SMS): the 10th SMS, activated November 1961; the 12th SMS, activated March 1962; and the 490th SMS, activated May 1962. The 564th SMS, activated 1965, becoming the fourth SMS

[11] Stuwe, 126.
[12] Julian Hamilton, "The Minuteman Stands Guard in Montana," *The Monitor*, 50 no. 1 (1963), 6.

and the first at Malmstrom outfitted with the next generation of Minuteman missiles, the Minuteman II. Between 1991 and today (2008), the 341st SMW would be redesignated three times: on 1 September 1991 it became the 341st MW, on 1 October 1997 it became the 341st Space Wing (SW), and on 1 July 2008, it reverted to the 341st MW. The 341st SMW would ultimately have four squadrons with a total of 200 LFs and 20 MAFs over 23,000 square miles of land in Montana, making it the largest Minuteman missile wing in the SAC. Its primary function as an ICBM squadron was to conduct strategic warfare in support of an Emergency War Order, which was the executive command to initiate launch procedures.

The first Minuteman I arrived at MAFB on 23 July 1962, and Launch Facility Alpha-09 became the first Minuteman missile site in the nation. On 26 October 1962 at 11:16 AM, the 10th SMS's LF Alpha-06 went on strategic alert in response to the placement of nuclear missiles in Cuba by the Soviet Union.[13] In all, the USAF placed five missiles on alert status. By 3 July 1963, four SMS were fully operational, including the 10th SMS, the 12th SMS, and the 490th SMS with a total of 150 Minuteman I nuclear missile sites in place. Although the US had other missiles systems in place, urban legend has it that the Minuteman ICBM missile system was considered the "Ace in the Hole."[14] This theme was carried into morale patches and murals within the 564th SMS as well as other SMS. The Minuteman had an efficient design, fast construction capability and launch processes, and it had greater speed and accuracy in comparison to its predecessors.

Construction of the original MAFs and LFs energized the local economy.[15] The average cost to construct a MAF was $1,668,000 and an LF was $575,000 in 1962.[16] In addition, the USAF acquired a total of 5,200 acres of land from local landowners and from the State of Montana for the actual MAF and LF sites.[17] The US government first gained rights of entry to determine if the site was viable for the Minuteman missile facility. The land was then appraised and the appraisal price was offered for a grant of deed or easement. Each MAF and LF required approximately 2 to 6 acres plus access roads and utility lines.[18] A total of 5,000 tradesmen were hired for the initial $62 million project. The US Army Corps of Engineers (USACE) in Seattle, under the direction of the USAF, oversaw the project and provided on-site direction through the Corps of Engineers Ballistic Missile Construction Office and the Site Activation Task Force. Two years later, in 1965, construction began for the 564th SMS, which would have 50 nuclear-tipped Minuteman II missiles by 1967.

Unlike the other three squadrons, the 564th SMS was originally equipped with the Minuteman II missiles while the other three SMS upgraded to Minuteman II missiles as a

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[13] Shannon, 20.
[14] Ibid.
[15] "Falls Area Tested for ICBM Sites," *The Choteau Acantha*, 5 February 1960.
[16] "Conrad Boomed When Missiles Went In," *The Choteau Acantha*, no date.
[17] Ibid.
[18] Ibid.

part of the Force Modernization Program of 1966 (completed 27 May 1969). The 564th SMS was declared fully operational on 5 May 1967, making the MAFB missile field the largest in the US, covering 23,500 square miles. At its peak in 1967, 1,000 Minuteman missiles remained on alert status in the US with 200 at MAFB, 150 at Minot AFB, North Dakota, 150 at Grand Forks AFB, North Dakota, 200 at FE Warren AFB, Wyoming, 150 at Ellsworth AFB, South Dakota, and 150 at Whiteman AFB, Missouri.

The 564th MS originated as the 564th BS (Heavy) on 19 December 1942 and was activated five days later. It was redesignated the 564th Bombardment Squadron, Heavy on 4 January 1944 and served at numerous bases and locations, including Davis-Monthan Field, Arizona; Biggs Field, Texas; Lowry Field, Colorado; Hethel, England; Bengasi, Libya; Massicault, Tunisia; and Charleston Army Air Field, South Carolina. On 13 September 1945, the squadron was inactivated. The squadron was later redesignated as the 564th Bombardment Squadron (Very Heavy) on 28 January 1948 and activated in the Reserve on 27 February 1948 and flew out of Fairfax Field, Kansas. On 27 June 1949, it was again inactivated. On 1 May 1958, it was redesignated the 564th SMS (ICBM-Atlas) and was assigned to FE Warren AFB in Wyoming. The squadron was activated on 1 July 1958 until 1 September 1964, when it was again inactivated. The 564th SMS (ICBM-Atlas) was redesignated and activated on 14 December 1965 as the 564th SMS. At that time, the 564th SMS was assigned to MAFB as a part of the 341st SMW and was known as the "Deuce" squadron because it received the Minuteman II missile. It was fully operational on 3 May 1967. On 1 September 1991, the 564th SMS was redesignated the 564th MS.

During the 1970s and 1980s, MAFB and the 564th SMS remained on alert, although no major international crisis such as the Cuban Missile Crisis occurred.[19] MAFB saw the activation of the 17th Defense Systems Evaluation Squadron (DSES), equipped with EB-57 Canberra aircraft, in the 1970s and the testing of the Hardened Mobile Launcher (HML) for small ICBM in 1988. The 17th DSES was activated to train NORAD air defense personnel in electronic countermeasures. The activation of the DSES, the testing of the HML, and the alert status of the 564th SMS exemplified the military approach to the Cold War at this time: observation, deterrent, and defense. The alert status of the 564th SMS, combined with the activation of the 17th DSES, NORAD, and HML, showed MAFB's observation arena approach. Although an immediate threat did not exist, the United States was still aware of the actions of other nations and was still ready to defend itself with these defense systems at MAFB, of which the 564th SMS played a major role as an ICBM squadron.

Upgrade of the 564th from a Minuteman II to a Minuteman III missile squadron was one of the most significant developments to national defense capabilities at MAFB during the late Cold War era. This improvement program began in late January 1975 when the first Minuteman III missiles arrived at the base. Less than six months later in July, all 50 of Minuteman IIIs deployed to 564th stood ready for service. They replaced an equal number of the base's less efficient Minuteman II missiles.

[19] Shannon, 20.

In the following year, the 564th SMS became the first squadron to receive remote targeting capability with the Command Data Buffer (CDB) command and control (targeting) system for the Minuteman III. The CDB facilitated rapid, remote targeting of the missiles in the event target priorities were reshuffled. In the past, these operations were done manually by maintenance crews who brought new tapes to the silos to reset the missile guidance computer. Retargeting with CDB meant that a missile combat crew member could transmit new target locations to individual missiles during their flights from the launch control center. This innovation added operational command and control flexibility that previously was unavailable to Strategic Air Command. [20] In 1978, the Guidance Improvement Program enhanced the accuracy of the squadron's missiles. The most recent modification named Rapid Execution and Combat Targeting (REACT) enabled the squadron to respond to National Command Authority targeting directives in near real time.[21]

In 1989 with the fall of the Berlin Wall, the Cold War theoretically came to an end. This change in the political climate triggered major changes in the US military. The SAC put Air Divisions (AD) at locations having both missiles and aircraft so a General Officer could mediate between the wing commanders.[22] The 40th Air Division relocated to MAFB from Wurtsmith AFB in Michigan under which the 341st SMW and the newly activated 301st Air refueling Wing (ARW) served. Both would see service in the Gulf War, with the 341st SMW providing support personnel for security, civil engineering, and other services. On 15 January, 1992, Malmstrom's host responsibilities were again transferred, this time to the Air Mobility Command's 301st ARW. Later, on 1 June, 1992, the Air Force restructured its major commands, deactivating the SAC and replacing it with Air Combat Command (ACC). The 301st ARW was redesignated the 43 ARW. In July of 1992 responsibility for the nation's ICBM force was transferred from ACC to Air Space Command and the 43rd ARW was redesignated as a group, transferring host responsibilities back to the 341 MW. [23]

MAFB saw other changes that also impacted the 564th SMS, which by 1991 was redesignated the 564th MS. The 564th MS used the REACT-B system, while the remaining three squadrons used the REACT-A system, giving them a different communication and command system. The REACT-B communication system is interconnected by both cable and radio signals, which was supposedly more survivable after a nuclear detonation. The REACT-A communication system is only a "spider web of cables within the squadron."[24] More importantly, the Strategic Arms Reduction Treaty (START), signed by President George H. W. Bush and Soviet Leader Mikhail

[20] Christina A. Curan and Jeffery A. Hess, "Minuteman III ICBM Launch Control Facility," (Minneapolis, MN: Hess, Roise, and Company, 1 November 1997), 38-40.
[21] Strategic Air Command, "341st Bombardment Wing, 341st Strategic Missile Wing," http:// www. Strategic-air-command.com/wings/0341.htm, 2008.
[22] Shannon, 20.
[23] Ibid., 21.
[24] Strategic Air Command, "Minuteman Missile History," http://www.strategic-air-command.com/ missile/Minuteman/Minuteman_Missile_history.htm, 2008.

Gorbachev, meant all Minuteman II missiles went off alert status to reduce the number of active nuclear warheads.[25] The START treaty only addressed Minuteman II missiles. Minuteman III missiles were not included in the treaty, and consequently could remain at full capacity on alert status. Support elements not directly associated with the ICBMs, such as bombers and tankers, were also taken off alert status to show a good faith effort at arms reduction. Removal of the Minuteman II missiles as a result of START took over three years, with the final missile removed in 1995. A new program, called Rivet Add, oversaw the removal of the Minuteman II missile warhead and storage of the Minuteman II rocket motors.

The REACT system was the first complete overhaul of the Minuteman III's command and control systems. A total of 120 Minuteman III missiles transferred from Grand Forks AFB's 321st MW to MAFB in 1995 and brought the wing strength back to 200. It was the first time since START that all missile wings associated with a single weapon system was on full alert status. A missile on full alert status meant that it was ready for deployment at all times, regardless of the whether a political situation required a launch-ready missile. Minuteman III missiles, even today, remain on full alert status as a defensive measure, ready to respond as needed. Despite MAFB again having a total of 200 Minuteman III missiles on alert status, nationally the ICBM system had been drastically reduced by START. At the height of the ICBM missile system in 1967, there had been 1,000 Minuteman missiles, but START reduced the number to 500 nationally.

In 1995, the Base Realignment and Closure (BRAC) Commission called for changes at MAFB, which could have resulted in immediate reductions to 564th MS.[26] Instead, BRAC called for the deactivation of the 43 Air Refueling Group and the assignment of the 819 Red Horse. The 564th MS remained intact and operational, as did the other squadrons, and the Minuteman III missiles remained a part of the nation's Strategic Deterrent system. The missiles constantly underwent extensive alterations, resulting in what was referred to by USAF Space Command staff as the Minuteman IIIB missile. Major programs were initiated to ensure the replacement of aging guidance systems, the remanufacture of solid-propellant (solid fuel) rocket motors, the replacement of standby power systems, the repair of launch facilities, and the installation of updated communications equipment.

By 2006, the future of the 564th MS and the 50 Minuteman III missiles associated with the squadron was uncertain. The military's Quadrennial Defense Review recommended dismantling 50 Minuteman III missiles in the US despite nuclear capabilities in Iran and North Korea, threats reminiscent of early Cold War conflicts with Soviet Union.[27] The 564th MS was chosen for deactivation to fulfill this recommendation because of its

[25] Shannon, 20.
[26] Shannon, 21.
[27] Robert G. Joseph, "Iran's Nuclear Program," http://www.state.gov/t/us/rm/63121.htm, 2006.; The Committee on Present Danger, "Iran's Nuclear Intentions and Capabilities," http://www. Committeeonthepresentdanger.org/IRANSNUCLEARINTENTIONSANDCAPABILITIES/tabid/702/

REACT-B command system, which was the only Sylvania system remaining among the 10 squadrons. After Montana politicians objected, a second report was issued by the Pentagon at the request of Congress. This second report arrived at the same conclusion as the Quadrennial Defense Review findings: the 564th MS and their 50 Minuteman III missiles should be deactivated. The wing would deactivate its Minuteman III REACT-B command and control systems, operated by the 564th Missile Squadron. The Minuteman III missiles removed during the deactivation will return to the weapon system's flight test and operation programs, extending the system's valuable service life. The primary motivation for this action was the fact that these missiles operated on a separate command system requiring different training, parts, operators, and maintenance, specifically the REACT-B system. The cost of maintaining the two separate Minuteman III command systems was in excess of $10 million annually.

The USAF devised a three-stage deactivation process for the 50 Minuteman III missiles over the course of two years. Phase 1 involved the removal of the LGM-30 Minuteman III missile, including the reentry system (RS), booster stages, and the missile guidance system (MGS). Hill AFB would receive the booster stages while the RS would go to the Department of Energy for disposition. MAFB or an appropriate unit would claim the MGS. Phase 2 required the removal of all salvageable materials and items from the MAFs and LFs, recovery of documents, removal of reusable equipment to supply storage, discontinuation of operational environmental control systems, draining of wells, draining of fluids (fuel, coolant, etc.), and draining of power (batteries, electrical filters, etc.). Phase 3 would be the closure of the MAF wastewater treatment facilities (sewage lagoons), removal of equipment, removal of storage tanks, and securing access doors, except the closure door, to allow START inspection. The MAFs and LFs would be monitored by drive-by inspections.

On 12 July 2007, the removal of the 50 Minuteman III missiles and missile components from the MAFs and LFs at MAFB began. The USAF planned to remove one missile per week for the remainder of the year, with the final missile being removed in July 2008. The mission had been completed by August 15, 2008 when the 564th was officially deactivated. The nuclear warheads will be stored at an undisclosed location while the booster rockets will be driven to Hill AFB (Utah) for storage and periodic testing at Vandenberg AFB in California.

Specifics of the Minuteman Missiles

The Minuteman missile evolved out of the early ICBM program established after World War II, the start of the Cold War with the Soviet Union, and the need to have a weapon system more efficient than the interceptor missiles such as the Atlas and Titan missiles. The US and the Soviet Union engaged in an arms race as a result of Cold War politics,

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Default.aspx, 2007.; Council of Foreign Relations, "State Sponsors: North Korea," http://www.cfr.org/Publication/9364, 2008.; Jonathan Pollack, "North Korea's Nuclear Weapons Program to 2015," http//www.nbr.org/publications/asia_policy/AP3/AP3Pollack.pdf, 2007.

and the threat of one nation gaining dominance in the arms race prompted the development of faster, deadlier weapons technologies. When the Soviet Union developed their atomic bomb in 1949, the US responded with a thermonuclear device that triggered a fusion reaction in hydrogen isotopes. The H-bomb, successfully tested in 1952, appeared to give the US the edge in the arms race, but one year later the Soviet Union created its own H-bomb.[28] Attention turned to the delivery of the weapon as the US had bombers to launch the weapon, but the Soviet Union lacked the intercontinental bombers for long-range delivery of missiles. The US explored this concept of both missiles and their delivery system by having two independent organizations, the RAND Corporation and a USAF committee code-named the Teapot Committee, evaluate the significance of the ICBM. In 1954, the USAF released the reports and both found that the ICBM was not only practical but could also be employed with enough speed to counteract the Soviet threat. A new agency, the Western Development Division (WDD) headed by Brigadier General Bernard A. Schriever, was formed with the mission of developing and having an ICBM weapon system operational within six years.

The WDD started its program by hiring the Convair Corporation to design a long-range ballistic missile.[29] Convair designed the Atlas missile, which was based largely on the design of the German V-2 missile. The Atlas missile was powered by rocket engines that burned a mixture of liquid fuel and oxidizer. Convair equipped the missile with a new and innovative airframe made of rings of paper-thin stainless steel stacked in a stovepipe formation and welded together. The cylinders were inflated with nitrogen gas, which, when launched, had a range of 5,000 miles. The Atlas was the nation's foremost ballistic missile, although its lack of flight-tests and fragile outer structure made it less than desirable as an ICBM weapon.

Because of these limitations, General Schriever and his team searched for an auxiliary missile, and in 1955 the USAF contracted with the Glenn L. Martin Company to produce a new ICBM. The new prototype was named Titan and used the same liquid propellants as the Atlas, although its two-stage design made its airframe more dependable. Like the Atlas, however, the Titan proved to be missing elements to make it an effective weapon, and by 1956 the USAF reduced the operating budget for the ballistic missile program, calling for the discontinuation of either the Atlas or Titan programs. By 1957, under the auspices of the Eisenhower administration, the ballistic missile budget was cut by more than $200 million dollars.

The Eisenhower administration was criticized for allowing a lapse in the US arms race, and scientists once again focused on improving the Atlas and Titan missiles in hopes of developing the ultimate ICBM. The primary issues with the missiles to date had been their complex design involving over 300,000 parts that required perfect operating conditions, volatile and corrosive liquid propellants, and a two-hour preparation time for launch. While many high-ranking officials in the USAF felt that the Atlas and Titan types of liquid-fueled missiles were the only option, General Schriever and his staff had been

[28] Hamilton, 1.
[29] Ibid., 4.

researching the possibility of a solid-fuel missile. The benefit of using a solid fuel versus liquid fuel was a faster launch response time because the fuel was stored in the missile instead of added to the missile after the launch command was received. Colonel Edward Hall was chosen to lead the development program for a solid-fuel missile due to his unwavering conviction about its potential. Colonel Hall and his staff of engineers began ongoing research in August 1957 to develop a missile with a range that could be varied by the positioning of its three interchangeable propulsion stages while simultaneously having fewer maintenance needs. Named Weapon System Q, Colonel Hall's proposed weapon system was ideal because its simpler design provided mass production for minimum expenditure, making it preferable over the Atlas and Titan. This new system could be stored vertically underground and would survive not only the launching, but it also had the structural integrity to survive the flight. Approved within 48

hours of its delivery to the USAF, the new ICBM missile was named Minuteman after the ever-ready Minutemen of the American Revolution. The new Minuteman weapon system addressed all of the USAF's needs in an ICBM system, including forward power projection, capability to engage at all levels, rapid deployment, rapid resupply, 24-hour readiness, short warning/response time, and a high level of technology. The new Minuteman ICBM represented a Cold War ideal that was prevalent in the national conscience at the time: "Peace through strength."[30]

The launch of Sputnik by the Soviet Union on 4 October 1957 pushed America back into the arms race at a frenetic pace. The feasibility of the Minuteman missile, in combination with concern over the Soviets having the capability of launching a missile towards a distant target, resulted in a major push for research funding, and by 1958 Minuteman appropriations had increased from $50 million to $140 million. Competition to build the new missile was immediate, and in 1958 the Boeing Airplane Company won the bid despite having no previous experience with missile construction. Boeing hired an extensive team to build and test the missile, including the Thiokol Chemical Company, the Aerojet General Corporation, the Hercules Powder Company, the Autonetics Division of North American Aviation, and the AVCO Corporation.[31] The initial development work occurred in Utah at Hill AFB. The new missile was half the size of the Atlas and the Titan missiles measuring 6 feet in diameter and 53 feet in height and weighing 68,000 pounds. It had an intended range of 6,300 miles (although launches proved it to be closer to 5,500 miles), flew at 15,000 miles per hour, and reached a height of 700 miles in flight.[32]

In terms of design, the Minuteman missile had three cylindrical, steel-cased propulsion stages stacked on top of each other with each cylinder smaller than the one beneath it. A hollow, star-shaped core, surrounded by a revolutionary technology of a solid mixture of fuel and oxidizer, and the guidance system was located in a small compartment above

[30] Ibid., 1.
[31] Ibid., 4.
[32] Ibid., 3.

the third stage.[33] The nose-cone was built to eventually house the thermonuclear warhead. In comparison to the Atlas and Titan missiles, with their 300,000 parts that required optimum storage conditions and large maintenance crews, the Minuteman missile wiring was on small cards that plugged into drawers in the console. Trouble areas could be easily identified and isolated and the card quickly replaced. Testing on the new missile began in 1960 at Cape Canaveral with the first successful firing of the Minuteman occurring on 1 February 1961. At this first successful firing, the three propulsion stages detached themselves and fell back to earth as designed while the unarmed warhead reached its test destination 4,600 miles away in the Atlantic Ocean within 25 minutes. Atlas and Titan missiles required at minimum 60 minutes for the fueling process. The Minuteman's entire launch sequence took half the time of the Atlas and Titan missiles' fueling process alone.

While the new missile was being designed, the USAF was also conceptualizing its ideal ICBM facility. This facility included underground LFs that allowed for the vertical storage of the missile in a ready launch position. The goal was for the facility to require only limited support and for the missile launch unit to be self-supporting for a period of two weeks. Both the Minuteman missile and its support facility design were economically feasible in comparison to the Atlas and Titan. The Minuteman required less electrical power and fuel storage space because it was a solid fuel missile, and its facilities appeared easier to maintain due to their simplicity and smaller crew requirements.

With the successful testing of the Minuteman missile, called the Minuteman I, the USAF hurried to deploy the new ICBM weapon system. Initially, the USAF wanted large "missile farms" comprised of 1,500 missiles, but research found that it was more economical to have concentrations of 150 LFs with a minimum 50 missiles. It was arranged in such a manner that for every 10 LFs, there was a central MAF (launch control facility) separated by approximately 10 nautical miles. The USAF chose sites in the northern US because they were closer to the United Soviet Socialist Republic (USSR) and could make the intended 5,500 mile range. MAFB was over 3,000 feet in elevation, allowing a greater range to the Soviet Union. The first Minuteman sites in the US were planned for MAFB in 1960 because of the low population density, the established road network, and the availability of land within the state of Montana. An updated version of the missile, called the Minuteman IB[34], was deployed to Ellsworth AFB in 1962 to the 66th SMS, the 67th SMS, and the 68th SMS; Minot AFB in 1963 to the 455th SMS; FE Warren AFB in 1963 to the 90th SMW; and Whiteman AFB in 1964 to the 351st SMW.

The Minuteman I was different from its predecessors for three primary reasons: it was a three-stage, solid propellant, rocket-powered ICBM; it had an inertial guidance system (digital computer); and it could be launched and stored in the same below ground silo quickly and efficiently. Earlier ICBMs like the Atlas and the Titan used liquid propellants,

[33] Headquarters Strategic Air Command, *Strategic Air Command Fact Book* (Offutt Air Force Base, NE: Directorate of Information, 1975), 30.
[34] Headquarters Strategic Air Command, 30.

which could not be stored in the missile and had to be added prior to launch. These earlier ICBMs also could not be stored and launched vertically underground, such as the Atlas, which was stored horizontally and launched vertically. The inertial guidance system was considered a risk at the time. A digital computer in a missile had proven difficult because of fitting such equipment into the missile. The reward of having such a computer, though, warranted another attempt because the computer allowed for better accuracy due to inertial guidance software and the computer could be used for testing. The Minuteman I missile was ultimately equipped with the Autonetics D-17 flight computer.

The Minuteman I missile had two variations: Minuteman IA and Minuteman IB.[35] The Minuteman IA, the original missile developed, was found to have a flaw in its first stage that reduced the range of the missile by 2,000 miles.[36] Three Minuteman squadrons were activated with the Minuteman IA, including the 10th SMS, activated on 1 December 1961; the 12th SMS, activated on 1 March 1962; and the 490th SMS, activated on 1 May 1962.[37] When the flaw was discovered, the USAF opted to deploy the Minuteman IA missiles while correcting the issue in the next version, the Minuteman IB missile, and the three missile squadrons at MAFB would be the only missile squadrons to use the Minuteman IA missile. The Minuteman IB missile was deployed in the next 13 Minuteman squadrons activated by SAC.

In 1963, with the Minuteman I newly deployed, the USAF began development of the Minuteman II missile, known as the F model. Deployment of the Minuteman II began in 1965 and included an increased range, a larger payload, a more efficient guidance system with better azimuthal coverage, and multiple target selection.[38] Specific improvements to the Minuteman II included an improved first-stage motor for increased reliability; a larger second stage motor with a single, fixed nozzle with liquid thrust vector (for increased missile range); an improved guidance system with semiconductor integrated circuits and miniaturized discrete electric parts (for multiple target selection and reduction in the size and weight of the guidance system); penetration aid system to conceal the nuclear warhead; and a larger W-56 warhead with a yield of 1.2 megatons in the Mk-11C reentry vehicle (for increased kill capabilities).[39] By 1967, deployment of the Minuteman II missile was complete.

The Minuteman III missile, or G model, was under development in 1964. Performance improvements focused on improvements to the third stage motor, increased flexibility in the reentry vehicle and penetration aids deployment, and an increase in the payload capacity.[40] Specific improvements associated with the Minuteman III missile include a

[35] Strategic Air Command, "Minuteman Missile History," http://www.strategic-air-command.com/missile/Minuteman/Minuteman_Missile_history.htm, 2008.
[36] Ibid.
[37] Ibid.
[38] Ibid.
[39] Ibid.
[40] Ibid.

larger third stage motor with a fuel injector (for increased range); a reentry system that deploys penetration aids; increased payload delivery due to up to three Mark 12 or Mark 12A reentry vehicles; a multiple independently targeted reentry vehicle (MIRV); a post-boost propulsion system (for increased range); and an improved guidance system.[41]

The development of anti-ballistic missiles by the USSR prompted the USAF to address the vulnerability of the Minuteman I and the Minuteman II missiles. To this end, scientists began developing the Minuteman III missile with an improved guidance system and a new warhead: the MIRV. The MIRV reentry system provided the Minuteman III with greater flexibility and precision. It was more resilient against enemy defensive measures, such as anti-ballistic missile (ABM) systems, because the Minuteman III had three warheads while the ABM had just one, per the requirements of the START treaty. The Minuteman III was viewed also as an offensive weapon because the MIRV enabled it to attack and wipe out Soviet nuclear weapons, forestalling a retaliatory act that would require defensive measures. The Minuteman III had a larger third-stage motor to increase range. It could be retargeted in minutes and could deliver three hydrogen bombs to scattered targets as far as 8,000 miles away.[42]

Test flights of the Minuteman III began in August 1968, with a successful launch from Cape Kennedy, Florida. As testing continued, objections to the Minuteman III mounted in Congress. In early 1970, in response to the profound implications of the missile's MIRV component, Senator Edward W. Brooks spearheaded an effort to persuade President Richard Nixon to postpone the deployment of the multi-warhead missile. Arms control talks between the Soviets and the US were scheduled for that April in Vienna, Austria, and Brooks called for a delay until arms control negotiators could discuss the subject. In defense of an on-schedule-deployment for the Minuteman III, Air Force secretary Robert C. Seamans Jr. told the Senate Armed Services Committee that in the event of a Soviet attack, "Minuteman III . . . surviving missiles could penetrate the Soviet anti-ballistic missile system."[43] In supporting testimony, USAF Chief of Staff General John D. Ryan agreed that the Minutemen III was necessary because the Soviet operational ICBM force already outnumbered that of the United States and that by mid-1970 it would "probably exceed ours by several hundred launchers."[44] Pentagon officials also cited Soviet developments as a key reason for the new missile, maintaining that the Soviets were believed to be deploying 50-megaton, multiple warheads on the SS-9, their most powerful ICBM. These arguments, and the fact that the Minutemen III program was well underway by the time the opposition gained momentum, left proponents of the new weapon confident that the President would move the deployment ahead as scheduled.

[41] Ibid.
[42] Ibid.
[43] Ibid.
[44] Ibid.

By March 1970, despite the protestations of a substantial Congressional faction, it became clear that the Minuteman III program would continue without delay.[45] Minot AFB received the first 150 Minuteman III missiles in 1970 and the new weapons were fully operational by 1971. Grand Forks AFB became operational in with 150 Minuteman III missiles in 1973. MAFB received and installed its 50 Minuteman IIIs between January and July of 1975. That same year, Warren AFB achieved operational status with Minuteman III, bringing the USAF's total missile count to 550.[46]

The Minuteman III was the first of the three Minuteman versions to reflect its modifications in a substantially different outward appearance. Larger than its two predecessors, the Minuteman III had only one diameter reduction past the first-stage motor, while the previous types of missiles had a reduction at each stage. The Minuteman III's technological changes were confined to the third-stage and above. Engineers added a larger third-stage motor to the missile, giving it a longer range and more powerful thrust than the Minuteman II. The most significant difference featured by the Minuteman III was the new Post-Boost Control System (PBCS) that sat atop the third stage motor. The PBCS consisted of two components: the Propulsion System Rocket Engine (PSRE) and an upgraded guidance assembly. The PSRE, manufactured by Bell

Aerospace of Buffalo, New York, was an engine that functioned as a fourth-stage bus for the Minuteman's new reentry system by providing added propulsion. It was driven by liquid fuel, the early such rocket engine in the solid-fueled Minuteman program. The guidance assembly was similar to that on the Minuteman II but had an increased power supply and more computer memory for better accuracy in positioning the reentry vehicle. Surmounting the PBCS was the new reentry system, the Post-Boost Vehicle (PBV), enclosed in the bullet-shaped tip of the missile.[47]

The PBV contained what the *New York Times* called the missile's "most telling advantage," the "revolutionary" Mark 12 MIRV. The MIRV could deliver three bombs, each of which could be positioned independently to hit three separate targets, thus dispersing destructive energy over a much broader geographic area. This improvement in the overall effectiveness of a missile allowed for a reduction of missile size in terms of overall power from a single 1.2 megaton bomb of the Minuteman II to three 200 kilotons bombs of the Minuteman III. The *New York Times* predicted that the Minuteman III and its MIRV capabilities would "render current and contemplated antimissile defense systems largely inadequate," and "thrust the world into a new era of weapons for mass destruction."[48]

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[45] Ibid.
[46] Ibid.
[47] Curren and Hess, 38-40.
[48] Ibid.

All three generations of Minuteman missiles utilized the same MAFs and LFs but with modification. The LFs saw the most change, as the Minuteman III was larger than the first two Minuteman missiles for which facilities were originally designed. Each launch tube was equipped with a new suspension system, designated to hold the missile absolutely motionless during a nuclear attack. A 10-inch thick layer of borated concrete was added to the top of each silo's closure door to protect the missile from radiation, and the ballistic actuators that opened the doors were rebuilt to handle the extra load. The refurbished silos were also equipped with a system of seals, filters, and surge arrestors designed to prevent sensitive electronic equipment from being damaged by the powerful electromagnetic waves generated during nuclear explosions.[49]

The Minuteman III brought little change to the physical appearance of the MAFs. However, important modifications were made to the computer programming inside the launch control centers.[50] In general, the physical arrangement of the MAFs and LFs was dependent upon the organization of the Minuteman force. The Minuteman force was divided into wings such as the 341st SMW at MAFB, which further divided into three to four 50-missile squadrons. For the 341st SMW, the four squadrons became the 10th MS, known as "First Aces;" the 12th MS, known as "Red Dawgs;" the 490th MS, known as "Farsiders;" and the 564th MS, known as "Deuce."

The crews chosen for the Missile Combat Crew (MCC) were originally hand-picked from volunteers and many already had degrees in engineering.[51] These men underwent extensive psychological examination to ensure their mental stability in order to launch a wartime nuclear missile.[52] Initially, a two-man crew spent 48 hours in the LCC, although today (2008) both men and women serve on the MCC and serve 24-hour shifts. The US government established various safeguards to prevent the unauthorized launch of a nuclear missile. The President initiates launching by ordering Space Command (formerly the SAC) to strike, with the orders verified by code. The two MCC crew each insert a key, which signals another MCC crew at another MAF to insert their launch keys. A third MCC is alerted, allowing for a very short lag time to halt the launch if necessary. Once the President gives the orders, and pending no cessation of the process, a Minuteman launch can occur within one minute.[53]

Of note, the primary difference between the four squadrons of the 341st SMW relates to the weapons system. All four squadrons operated and maintained the REACT weapon system, but the 10th MS, 12th MS, and 490th MS operated and maintained the REACT-A

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[49] James C. Bard, Sara A. Scott and David C. Schwab, "Base and Missile Cold War Survey: A Baseline Inventory of Cold War Material Culture at Malmstrom Air Force Base, Montana" (Englewood, CO: CHM Hill, March 1, 1997), 75.
[50] Curren and Hess, 38-40
[51] Hamilton, 5.
[52] Ibid.
[53] Hamilton, 5.

weapons system while the 564th operated the REACT-B weapon system.[54] The REACT weapon system was developed to improve the emergency war order supportability through upgrades to the electronic systems in the LCC. The previous system, the Command Data Buffer System, required at minimum 30 minutes for missile retargeting while the REACT weapon system streamlined this process to just a matter of minutes.

The REACT weapon system had two major components: a weapon system control element (WSCE) and the higher authority communications/rapid message processing element (HAC/RMPE). The difference between the two weapon systems was the communication method. The REACT-B weapon system sustained communication between the squadrons through a connection of underground cable lines and radio signals.[55] This communication system was considered to have a better chance of survival after a nuclear detonation than the REACT-A weapon system, in which the squadrons remained connected by a network of underground cables only. It was because of the REACT-B system, which required extra budgetary considerations for training and maintenance, that the 564th MS was deactivated.

PART II. DESCRIPTIVE INFORMATION:

Each of the four squadrons, the 10th MS, the 12th MS, the 490th MS, and the 564th MS, further divided into flights, which consisted of a MAF linked to 10 LFs. Documentation of the five MAFs associated with the 564th MS at MAFB occurred during the week of 15 October 2007. These include Papa MAF, Quebec MAF, Romeo MAF, Sierra MAF, and Tango MAF. Three LFs were documented as a representation of the 50 LFs: Quebec-15 LF, Quebec-16 LF, and Quebec-19 LF. The MAFs and LFs, all built in 1966, followed designs by the Ralph M. Parsons Company of Los Angeles, California and were constructed by Morrison Knudsen Company and Associates. The MAF is a predominantly above-ground building known as a "soft" support building because of its vulnerability to nuclear attack. Its purpose is to house the launch personnel and protect and control the launch equipment. The MAFs associated with the 564th MS differed from earlier MAF blueprints, which were designed in the early 1960s by Parson-Wenzel. Earlier MAFs had detached garages and outbuildings and were not self-contained. The MAFs associated with the 564th were built to be self-contained with no outbuildings, had an attached garage, and offered minimal exposure of antennas and electrical equipment.

Missile Alert Facilities

The five MAFs of the 564th were all built on the same floor plan. Their exterior and interior features are identical aside from differences in their names, locations, orientation, associated LFs, and interior aesthetics. All five MAFs are enclosed on 2 to 3 acre sites and include the MAF (previously called the Launch Control Facility), a helicopter pad, paved parking, and a variety of above and below ground antennas. The

[54] Ken Parsons and Anthony Lucas, 341 CES/CEVC, Malmstrom Air Force Base, interview by Mathia Scherer, 16 October 2007.
[55] Ibid.

building and antennas are enclosed within a chain link fence. Agricultural land typically surrounds the fenced USAF properties.

Each MAF is a one-story, L-shaped building with a concrete slab foundation, although a portion of the building is 47 feet below ground. Numerous antennas and vents are scattered across the roof. Beginning in the 1990s, the five MAFs underwent interior and exterior alteration, including the replacement of siding and roofing materials. The original green wood siding was replaced with yellow vinyl siding in various shades, and the low-pitched gable roofs have replacement asphalt shingles. Other exterior alterations include modern fixed and sliding windows, new single and double metal doors, and replacement vehicle bay doors. Interior alterations were predominantly aesthetic. The layout of the building remained the same, but the installation of new carpet, new paint, changes in furniture, and new room decorations have occurred.

The MAF for the Minuteman III has three components: the Launch Control Support Building (LCSB), the Launch Control Equipment Building (LCEB), and the LCC.[56] The LCSB is the above-ground area of the building and provides not only housing for the Minutemen crew and equipment but also controlled access to the facility. The majority of the LCSB is dedicated to living space (personnel support area) and equipment storage. This equipment includes communication, generators, and water treatment equipment. The Flight Security Control Center (FSCC) is located at the entrance of the building, which provides access to the subterranean areas of the building, specifically the LCEB and the LCC.

The LCEB and the LCC are small capsules 47 feet below the LCSB.[57] Both are accessed through the FSCC and are built with 4½ feet thick reinforced concrete. The LCEB is a large equipment room that supports the LCC and provides the environment for sustained self-sufficiency. It is separated from the LCC by the tunnel junction and an eight-ton blast door, which protects the LCC.[58] It houses the MCC and the equipment for a missile launch, the most prominent of which is the console. The LCC is connected to its 10 LFs by a system of underground cables and aboveground radio antenna.[59]

The LFs are remote, unmanned missile silos that have a perpetual ready-to-launch status.[60] The LFs are considered hard buildings (resistant to all but a direct nuclear attack). The LFs for the Minuteman III missiles have two components: the launcher and the launch support building (LSB). The launcher consists of the launch tube, the two-floor Launch Equipment Room (LER), and the launcher closure. The launch tube is the

[56] Ken Parsons, "341 CES/CEVC Minuteman Weapon Generalization Familiarization Handbook," (Malmstrom Air Force Base: Missile Engineering QA Office, 1997), 1-5.
[57] Headquarters Strategic Air Command, 30.
[58] Christina Slattery et al., "Minuteman ICBM Launch Control Facility Delta 0-1 and Launch Facility Delta 0-9, Ellsworth Air Force Base National Register of Historic Places Nomination Form," http://www.nps.gov/archive/mimi/history/srs/hrsab.pdf, 2003.
[59] Parsons and Lucas.
[60] Ibid.

cylindrical silo in which the missile is stored. It has a steel liner for protection from erosion, flying debris, and electromagnetic interference.[61] The missile is protected by a suspension system that also helps with its guidance. The LER encircles the launch tube and holds the equipment necessary for moving and launching the missile. This equipment includes batteries, a winch, and umbilical cords that are shock-mounted on the upper floor.[62] Located between the LER floor and the launch tube is a 6 to 8 inch gap that allows for motion from reverberations. The launch closure is a four-and-a-half foot thick, reinforced concrete slab that covers the launcher, protecting it against nuclear blast pressure, extreme thermal effects, and a follow-up vacuum.[63] At launch, it is opened by a ballistic actuator operated on four 18-inch steel wheels, and can also be manually opened for maintenance.[64] It rests on a steel bearing ring that circles the top of the launch tube while mated beveled edges prevent vertical movement. Horizontal movement is prevented by a lock.[65] The launcher is accessible by a personal access hatch.

The LSB sits next to the Launcher, although it has a separate access hatch. The equipment in the LSB keeps the Launcher on strategic alert but is not used for missile launches.[66] Some Minuteman missile squadron LFs, such as the 564th MS, have a Launch Equipment Building (LEB) rather than an LSB, which the other missile squadrons in the 341st MW have. The components of the LEB are the same as the LSB but are underground in a hard building (protected from all but direct nuclear assault) rather than above-ground in a soft building. The LEB represents, in addition to its operating system, another differentiation between the 564th MS and other missile squadrons.

For a more detailed description of the Papa MAF, please refer to HAER No. MT-138-A. For a more detailed description of Quebec-19 LF, please refer to HAER No. MT-138-H. For shorter descriptions of the remaining MAFs and LFs, please refer to HAER No. MT-138-B through MT-138-G.

PART III: ACRONYMS

AAB	Army Air Base
ABM	Anti Ballistic Missile
ACC	Air Combat Command
AD	Air Division
AFB	Air Force Base
ARS	Air Refueling Squadron
ARW	Air Refueling Wing

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[61] Slattery et al.
[62] Ibid.
[63] Parsons, 1-5.
[64] Ibid.
[65] Ibid.
[66] Slattery et al.

ATW	Air Transport Wing
BG	Bombardment Group
BRAC	Base Realignment and Closure
BS	Bombardment Squadron
BW	Bombardment Wing
CDB	Command Data Buffer
DSES	Defense Systems Evaluation Squadron
FSCC	Flight Security Control Center
GF	Great Falls
HAC	Higher Authority Command
HML	Hardened Mobile Launcher
ICBM	Intercontinental Ballistic Missile
LCC	Launch Control Center
LCEB	Launch Control Equipment Building
LCSB	Launch Control Support Building
LEB	Launcher Equipment Building
LF	Launch Facility
LSB	Launcher Support Building
MAF	Missile Alert Facility
MAFB	Malmstrom Air Force Base
MCC	Missile Control Crew
MGS	Missile Guidance System
MIRV	Multiple Independently Reentry Vehicle
MS	Missile Squadron
MW	Missile Wing
NORAD	North American Aerospace Defense Command
PBCS	Post-Boost Control System
PBV	Post-Boost Vehicle
PSRE	Propulsion System Rocket Engine
REACT	Rapid Execution and Combat Targeting
RMPE	Rapid Message Processing Element
RS	Reentry System
SAC	Strategic Air Command
SAGE	Semiautomatic Ground Environment
SFW	Strategic Fighter Wing
SMS	Strategic Missile Squadron
SMW	Strategic Missile Wing
START	Strategic Arms Reduction Treaty
SW	Space Wing
USACE	US Army Corps of Engineers
USAF	United States Air Force
USSR	United Soviet Socialist Republic
WASP	Women Air Force Service Pilot
WDD	Western Development Division
WSCE	Weapon System Control Element

PART IV. SOURCES OF INFORMATION:

A. ORIGINAL ARCHITECTURAL DRAWINGS

341 CES/CEVC, Malmstrom Air Force Base, Montana 59402

B. GENERAL DEPOSITORIES

341 CES/CEVC, Malmstrom Air Force Base, Montana 59402

Great Falls Public Library, 301 Second Avenue North, Great Falls, MT, 59401

Cascade County Historical Society, 422 2nd Street South, Great Falls, MT 59401

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Montana Historical Society, PO Box 201201, 225 North Roberts, Helena, MT 59620

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Additional Sources

For a list of additional materials reviewed, interviews conducted and field notes taken by project historian Mathia Scherer see, Field Notes, HAER No. MT-138.

PART V. PROJECT INFORMATION:

HISTORIC AMERICAN ENGINEERING RECORD documentation was prepared on Papa Missile Alert Facility, Quebec Missile Alert Facility, Romeo Missile Alert Facility, Sierra Missile Alert Facility, Tango Missile Alert Facility, Quebec-15 Launch Facility, Quebec-16 Launch Facility, and -19 Launch Facility which are part of Malmstrom Air Force Base in accordance with the Memorandum of Agreement between Malmstrom Air Force Base, the Montana State Historic Preservation Office, and the Advisory Council on Historic Preservation.

Mathia N. Scherer, architectural historian, AMEC Earth & Environmental, Inc., 690 Commonwealth Center, 11003 Bluegrass Parkway, Louisville, Kentucky 40299 (502-267-0700) under contract to the Air Force Center for Environmental Excellence prepared the narrative report and assisted with photographing the site in October 2007. Research was completed in October 2007 and January 2008.

Kristi Hager, architectural photographer, 430 East Spruce Street, Missoula, Montana 59082 (406-327-6681) under contract to Ethnoscience, 4140 King Avenue East, Billings, Montana 59101 (406-252-9163) under contract to AMEC Earth & Environmental, Inc., 201 East Broadway Suite B, Helena, Montana 59601 (406-449-6009) under contract to the Air Force Center for Environmental Excellence photographed the site in October 2007.

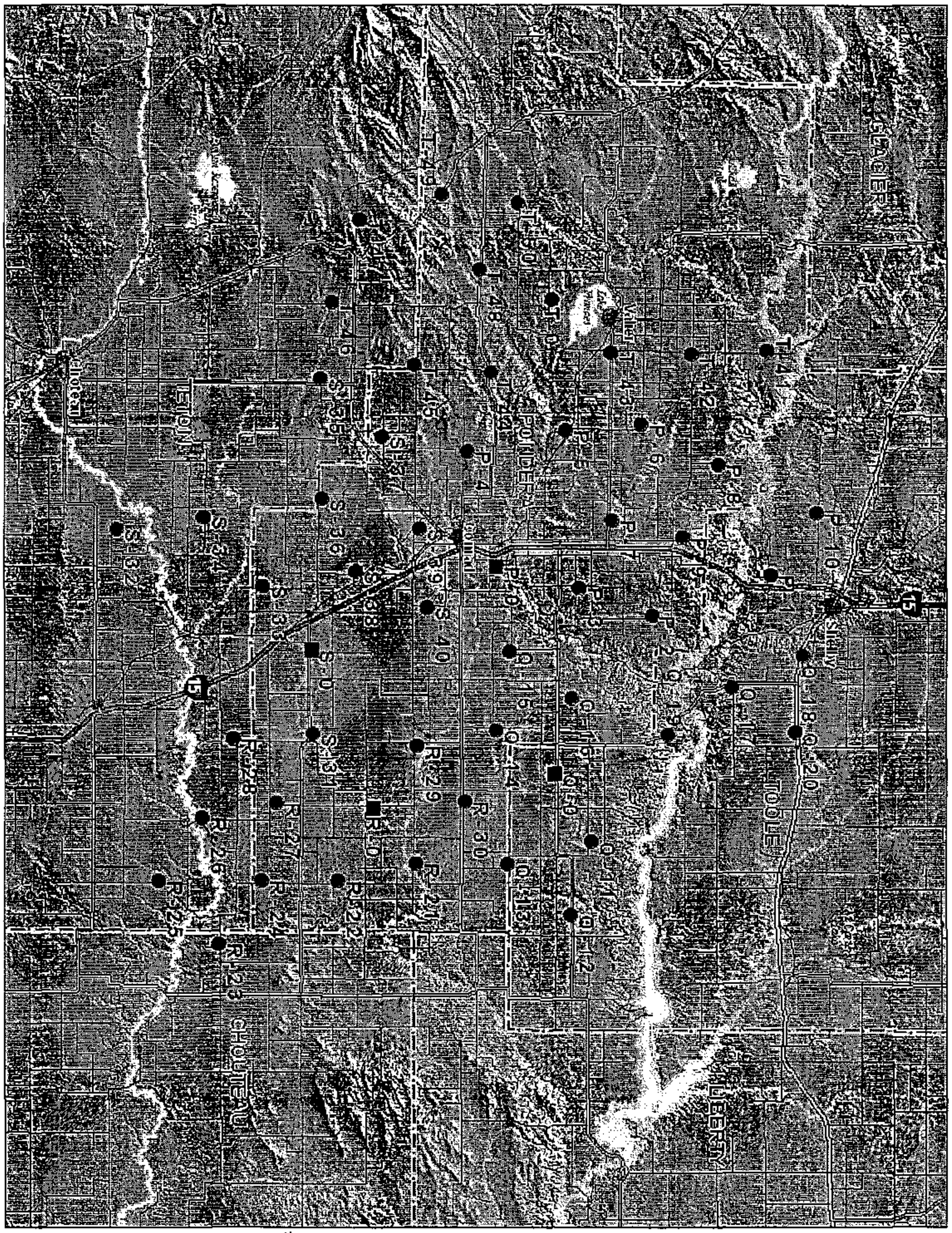


Figure 1. Locations of the 564[th] MS MAFs (identified with square markers and the number 0) and LFs (identified with round markers and numbers 1-50. On file, Malmstrom Air Force Base, 341 Civil Engineering Squadron.

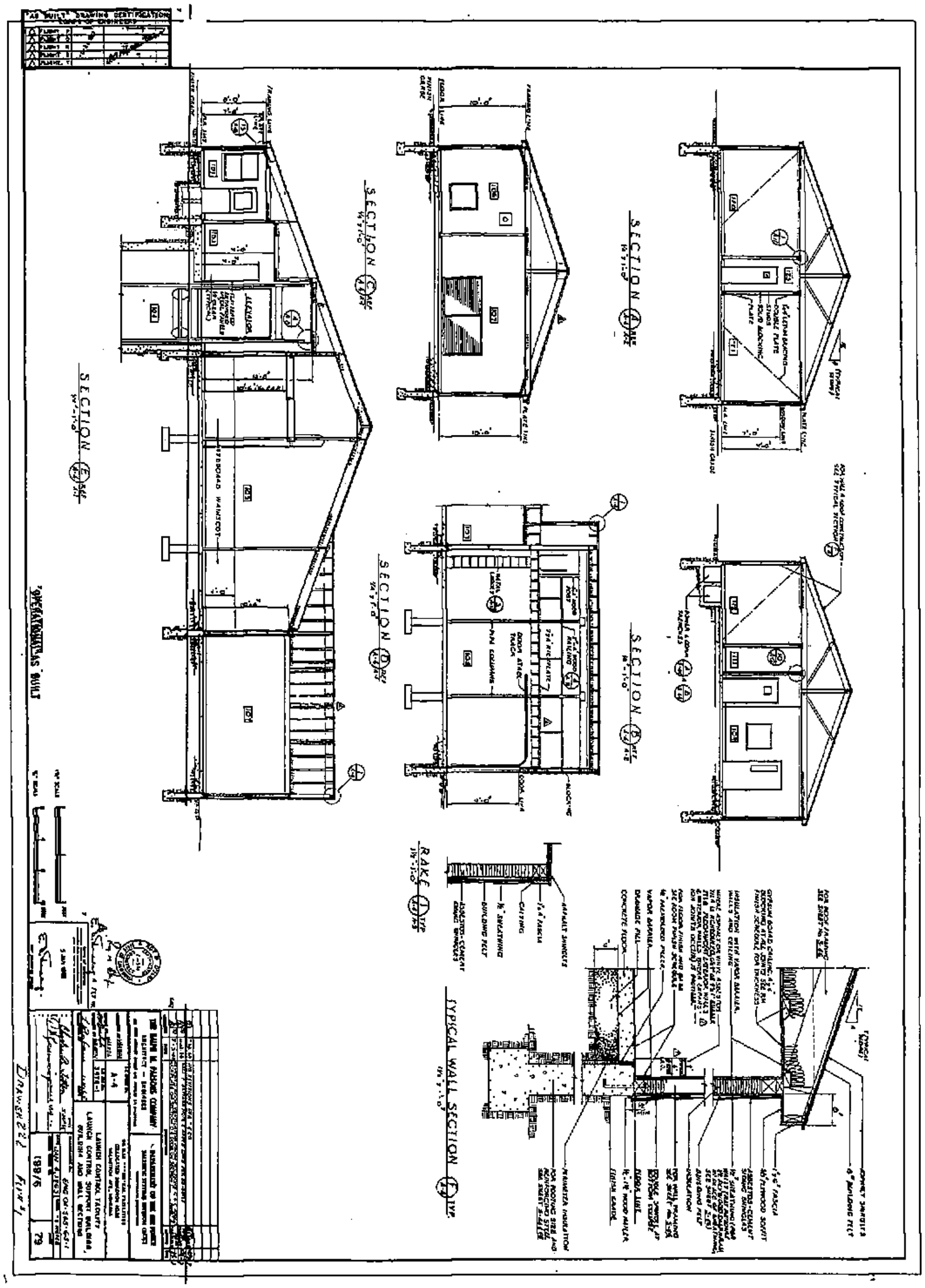


Figure 2. The 1965 Blueprint from the Ralph M. Parson Company of the Missile Alert Facility - Elevations. On file, Malmstrom Air Force Base, 341 Civil Engineer Squadron.

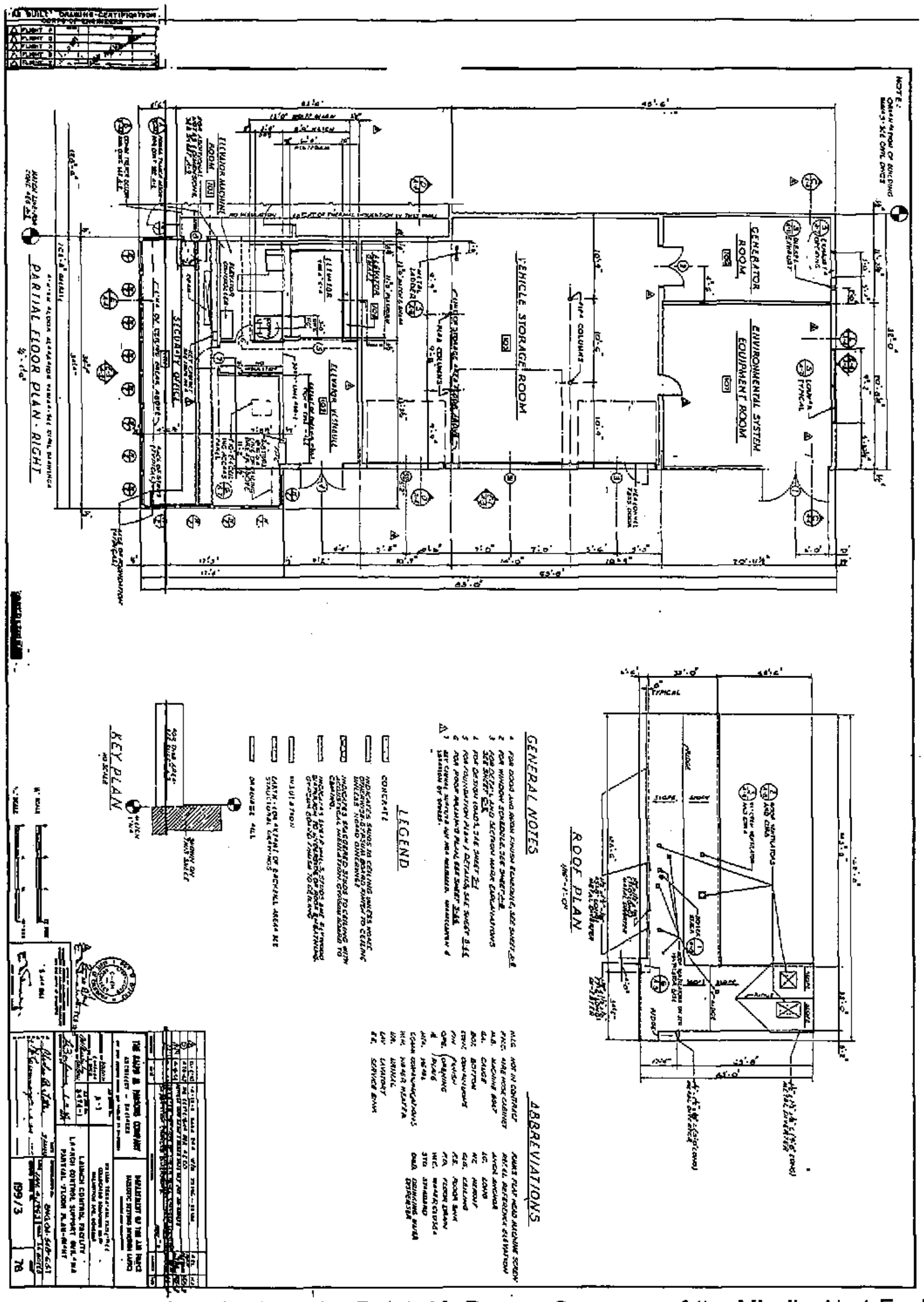


Figure 3. The 1965 Blueprint from the Ralph M. Parson Company of the Missile Alert Facility of Partial Floor Plan of LCSB - Right. On file, Malmstrom Air Force Base, 341 Civil Engineer Squadron.

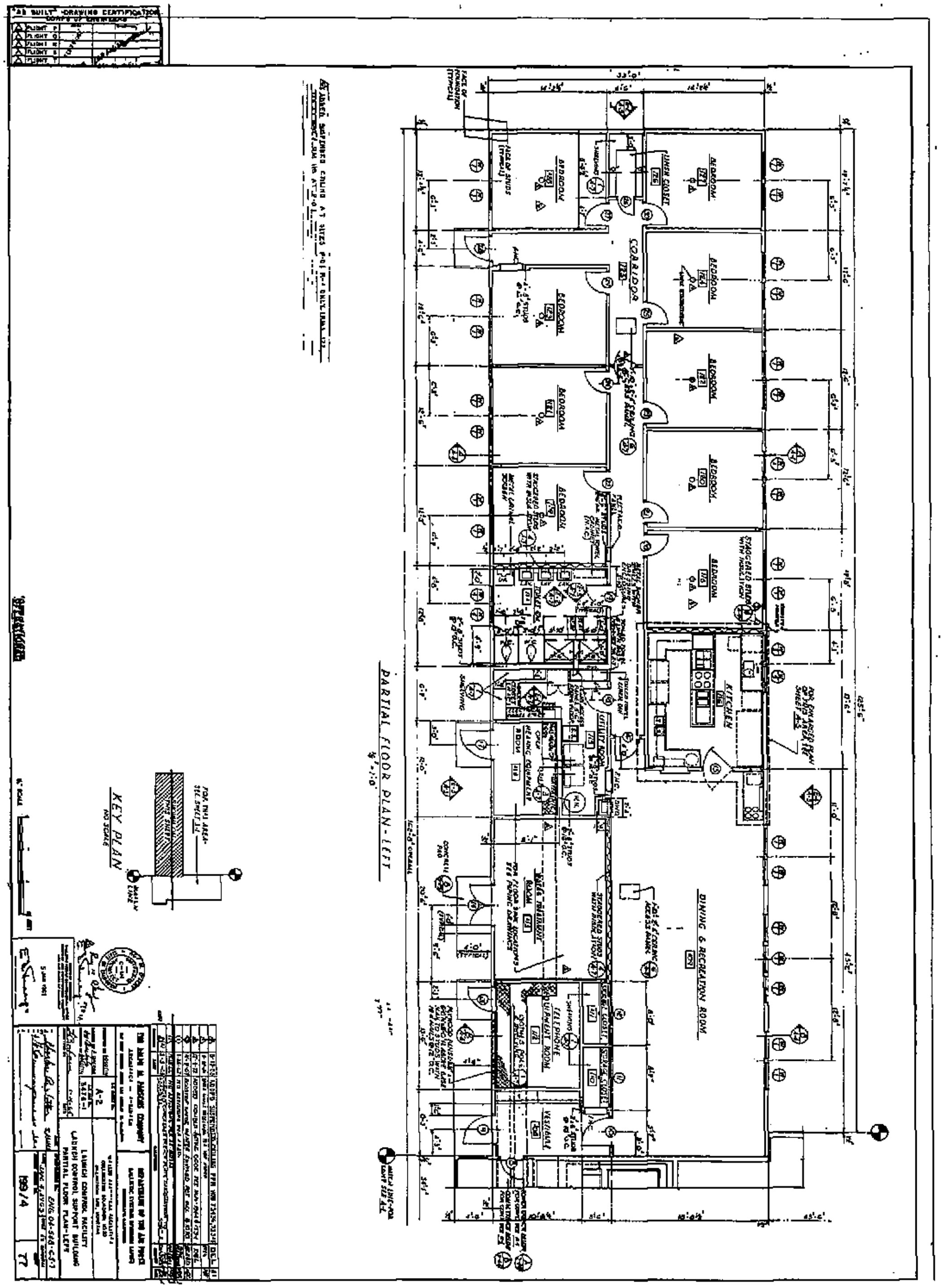


Figure 4. The 1965 Blueprint from the Ralph M. Parson Company of the Missile Alert Facility of Partial Floor Plan of LCSB - Left. On file, Malmstrom Air Force Base, 341 Civil Engineer Squadron.

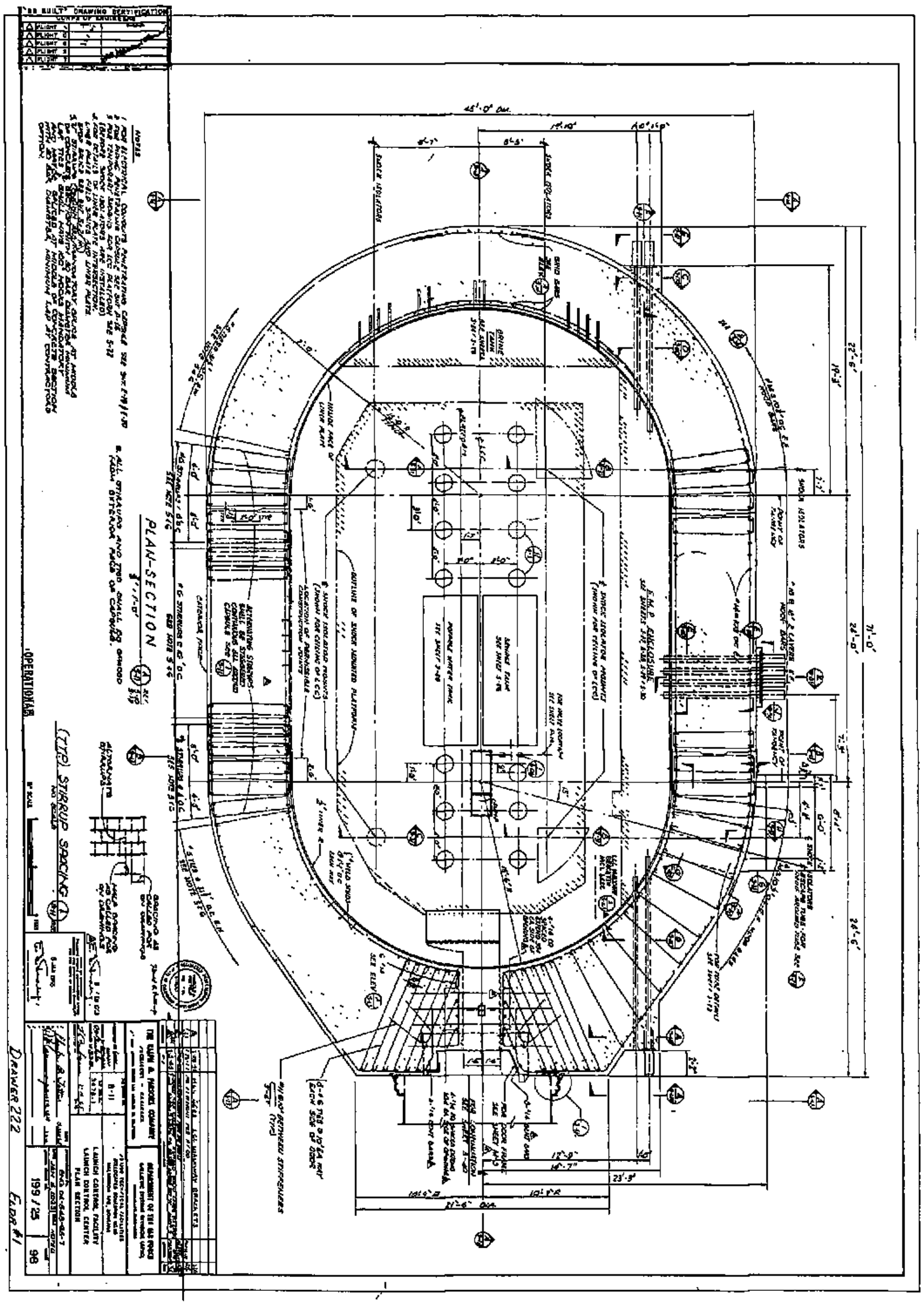


Figure 5. The 1965 Blueprint from the Ralph M. Parson Company of the Launch Facility – LCC Plan Section. On file, Malmstrom Air Force Base, 341 Civil Engineer Squadron.

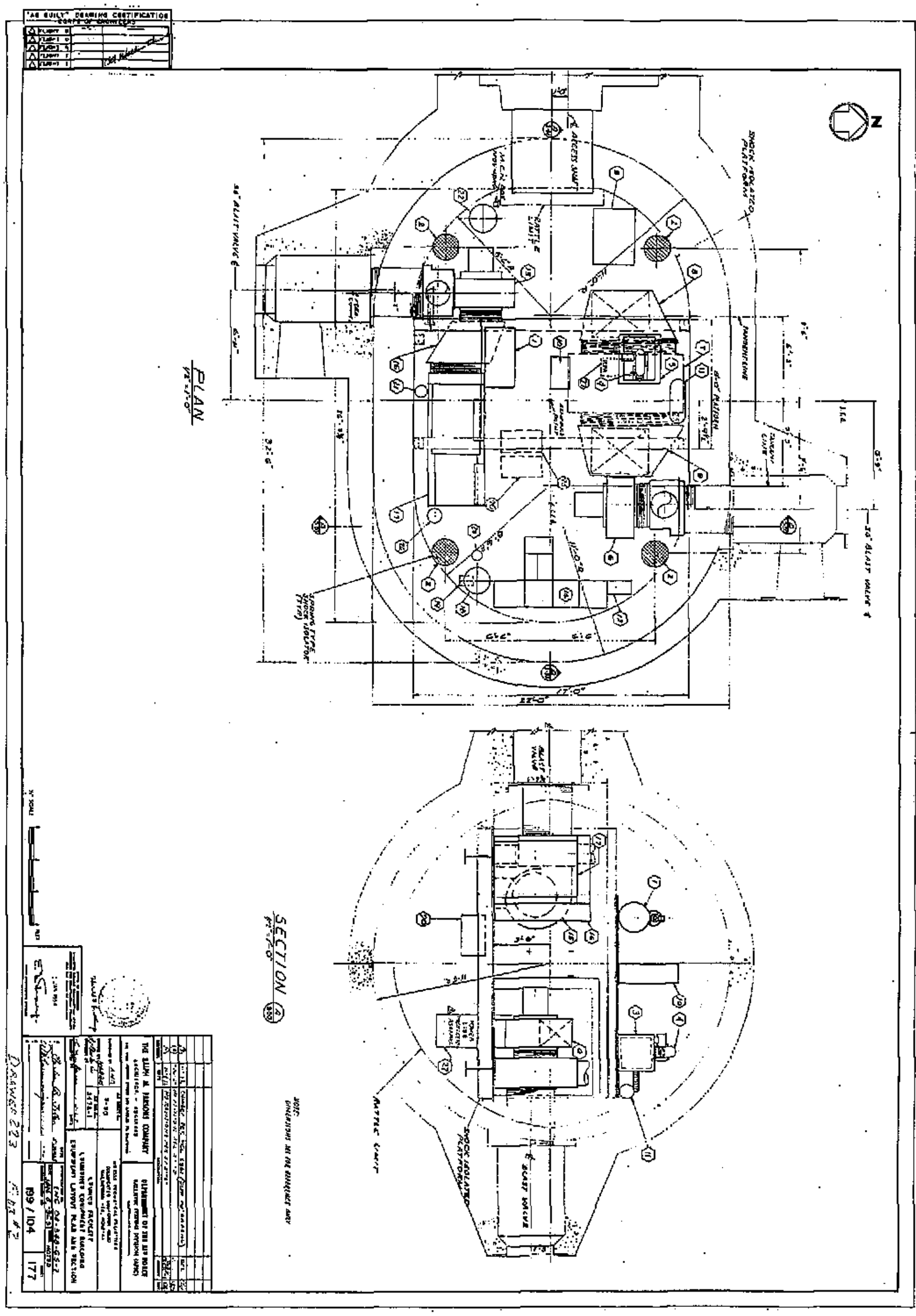


Figure 6. The 1965 Blueprint from the Ralph M. Parson Company of the Launch Facility – LEB Plan Section. On file, Malmstrom Air Force Base, 341 Civil Engineer Squadron.

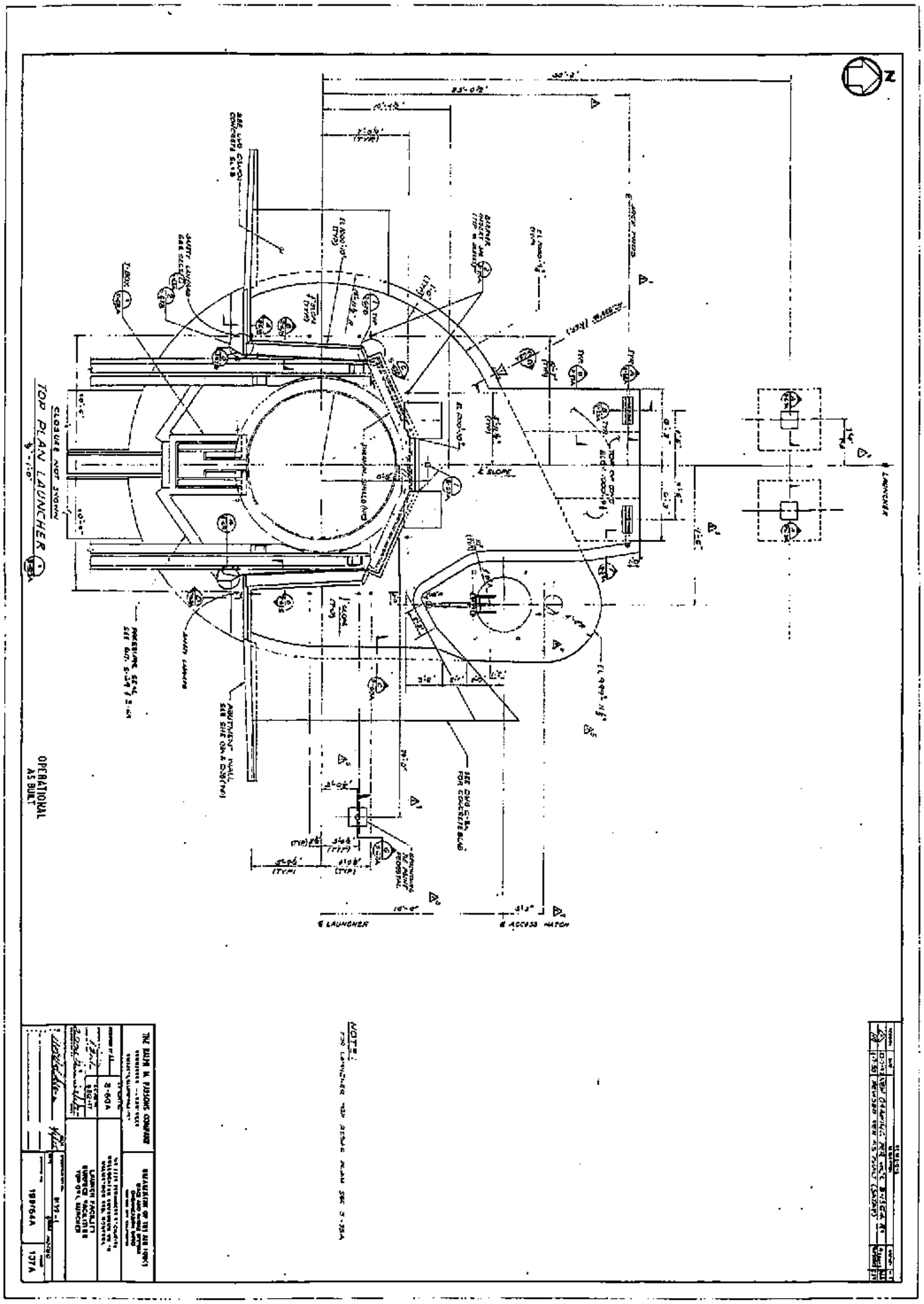
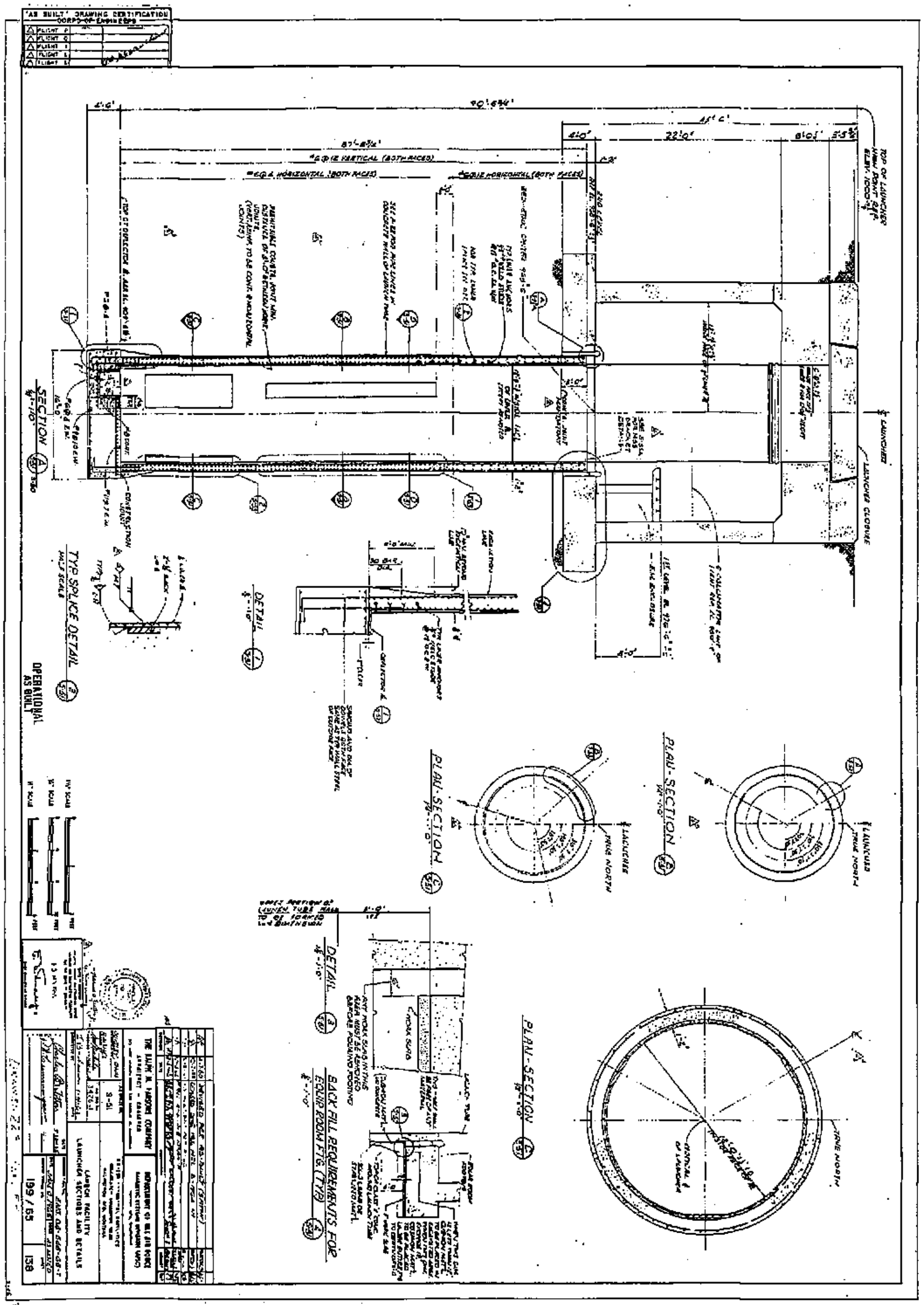


Figure 7. The 1965 Blueprint from the Ralph M. Parson Company of the Launch Facility – Top of Launcher. On file, Malmstrom Air Force Base, 341 Civil Engineer Squadron.



The 1965 Blueprint from the Ralph M. Parson Company of the Launch Facility – Launcher Section and Details. On file, Malmstrom Air Force Base, 341 Civil Engineer Squadron.